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(54) Title of the Invention
METHOD OF MANUFACTURING PRINTED WIRING BOARD

(57) Abstract

(Purpose) To provide a printed wiring board that enables miniaturization and high density.

(Constitution) A metal foil on one side of which an electronic component is electrically connected is disposed within a cavity of a molding die in such a manner that an electronic component mounting surface faces an inner side of the cavity, followed by injecting a molding material made of a thermosetting resin therein and curing the same.

Specification

1. Title of the Invention

METHOD OF MANUFACTURING PRINTED WIRING BOARD

2. Claim

[Claim 1]

A method of manufacturing a printed wiring board, comprising the step of: disposing a metal foil on one side of which an electronic component is electrically connected within a cavity of a molding die in such a manner that an electronic component mounting surface faces an inner side of the cavity, followed by injecting a molding material made of a thermosetting resin therein and curing the same.

3. Detailed Description of the Invention

(Field of Industrial Application)

The present invention particularly relates to a printed wiring board that is used for equipment requiring miniaturization and high density.

(Prior Art)

In order to enable miniaturized and high-density electronic equipment, it is important to minimize the space occupied by electronic components and a board that constitute a circuit. Regarding the electronic components, the development of the miniaturized and low-profiled electronic components has been progressed as can be seen from surface-mount type electronic components. Furthermore, regarding a board on which components are to be mounted, a flexible printed wiring board has been used conventionally. The flexible printed wiring board is obtained by forming a conductive pattern on a flexible film. Since the board itself is thin and can be bent, this board allows the effective use of narrow space. However, a base film of the flexible printed wiring board is required to have heat-resisting properties, and therefore expensive resins such as polyimide are used. Additionally, since the film has flexibility, there remains a problem concerning the stability during the mounting process of components and after the assembly into the equipment.

Meanwhile, there are methods in which a plurality of boards on each of which components are mounted are laminated to form a multilayered board with the components embedded therein in order to achieve the miniaturized and high-density board (e.g., JP H2-164096 A and JP H4-44296 A) and in which components are embedded in a case of electronic equipment (e.g., JP S57-50494 A).

(Problems to be Solved by the Invention)

According to the former method, holes should be bored in the board where the components are to be embedded, which requires processing such as spot facing. Such complicated boring is disadvantageous in terms of the cost. Furthermore, since the components are to be connected to an internal layer circuit, at least one or more internal layers are required, which complicates the manufacturing process. According to the latter method, the conductive pattern that is formed by plating is transferred to the board, and therefore this plating process is required. Furthermore, since the conductive layer is formed only on one side, the density of the circuit is equal to that of a one-side printed wiring board. Therefore, with the foregoing in mind, it is an object of the present invention to provide a printed wiring board that enables miniaturization and high-density.

(Means to Solve the Problems)

The present invention relates to a method of manufacturing a printed wiring board, comprising the step of: disposing a metal foil on one side of which an electronic component is electrically connected within a cavity of a molding die in such a manner that an electronic component mounting surface faces an inner side of the cavity, followed by injecting a molding material made of a thermosetting resin therein and curing the same. Now referring to Fig. 1, the present invention will be described below in detail.

Figs. 1(a) to (c) show an example of a method of manufacturing a printed wiring board of the present invention. First of all, as shown in Fig. 1(a), electronic components 2 are connected and fixed onto a metal foil 1 using a connecting material 3. Next, as shown in Fig. 1(b), the metal foil is disposed within a cavity 6 made up of an upper die 4 and a lower die 5 in such a manner that a component mounting surface faces an inner side of the cavity, followed by injecting a molding material made of a thermosetting

resin and curing the same. In this way, a printed wiring board can be obtained as shown in Fig. 1(c), in which the components are inserted in the insulative resin 7. The metal foil is a conductor functioning as a surface circuit, and is not limited especially. Although any metal foil may be used depending on the application, a copper foil used for general printed wiring boards is preferable in terms of the electrical connecting properties, the circuit formation properties and the cost. The thickness of the foil may be selected appropriately as needed. The shape of the metal foil is not limited especially, and it may have the same size as the board as a whole, or may be arranged partially at a plurality of positions. On a surface of such a metal foil on which the electronic components are to be mounted, a protective coating such as solder resist may be formed at portions except for the portions to which leads of the electronic components or the like are to be connected. Moreover, rough processing may be performed on portions of the metal foil contacting with the insulative resin, or a treatment with a coupling agent or an adhesive may be performed on the portions so as to allow the enhancement of the adhesion with the insulative resin.

The electronic components mounted on the metal foil are not limited especially and surface-mount type components, e.g., active elements such as ICs encapsulated on a surface-mount type package, transistors, diodes and passive elements such as chip resistors, chip capacitors and chip inductors are preferable. In addition, a metal wiring and a metal board that are a part of the wiring, bare chips such as not-encapsulated ICs and transistors may be mounted thereon. Although the size of these electronic components is not limited especially, components thinner than the thickness of the board allow a flat board to be obtained. Furthermore, in the case where components with thicknesses not more than half of the thickness of the board are used, the lamination can be conducted in the direction of the thickness of the board, which can enhance the mounting density.

As the connecting material that connects the electronic components with the metal foil, a general solder, conductive paste or the like may be used. In the case where a semiconductor element is mounted in a bare chip state, a connecting wire made of gold and aluminum (bonding wire) may be used, or bumps made of gold, palladium, solder and the like may be used for the connection. The shape of the cavity of the molding die for molding the board is not limited especially, and any shape may be adopted as long as the

molding can be conducted. In the case where a circuit is formed or assembling is performed with respect to the board obtained from the method of the present invention by the same process as for the conventional board, a planar cavity is preferable.

The insulative resin is a cured molding material made of a thermosetting resin. As the thermosetting resin, any resins such as phenol resin, epoxy resin, polyimide resin, unsaturated polyester resin and triazine resin may be used, and several types of resins may be used together. Especially, a system in which phenol resin is mixed as a curing agent with epoxy resin has excellent heat–resisting properties and electrical properties. Furthermore, a proper amount of additives such as a hardening accelerator that accelerates the curing reaction, a fire retardant that assigns fire retardant properties, a coloring agent and a release agent may be mixed to these resins as needed.

Various fillers may be mixed with these resin groups so as to allow the enhancement of thermal conductivity and the matching of thermal expansion coefficient with the inserted components. For example, powders of inorganics such as fused silica, crystalline silica, alumina and silicon nitride or organics such as silicone and Teflon may be used, which may be used alone or several types of them may be used together. The particle diameter of the fillers may be any one as long as they do not clog the gate of the molding die, and the shape of them may be any one. Although the mixing amount of the filler is not limited especially, the range of 20 to 80 volume% is preferable in terms of the melting viscosity of the resin component and thermal expansion coefficients of the cured material. When the filler is mixed, a coupling agent typified by silane based coupling agents may be added so as to enhance the adhesion with the resin. Regarding the molding method, general molding methods of molding materials can be used, including cast, transfer molding, injection molding, compression molding and the like. Heat and pressure may be applied if needed. Fig. 1(d) shows an example where a plating through hole and a circuit pattern are formed and components are mounted with respect to the printed wiring board obtained from the method of the present invention.

(Effects)

According to the printed wiring board obtained from the method of

the present invention, since electronic components are inserted in the insulative resin, a mounting density that is twice the mounting density of a conventional board can be obtained at the maximum. Furthermore, since the insulative resin is a cured molding material made of a thermosetting resin, excellent heat-resisting properties can be obtained. Moreover, the use of the molding material can eliminate the boring process such as spot facing for inserting the components.

(Working Example)

The following describes the present invention by way of working examples, but the present invention is not limited to the following working examples.

Working Example 1

ESCN-195 (trade name, produced by Sumitomo Chemical Co., Ltd. o-cresol novolac type epoxy resin)	: 100 parts by weight
HP-800N (trade name, produced by HITACHI CHEM CO LTD, phenolic novolac resin)	: 50 parts by weight
Alumina powder	: 950 parts by weight
Epoxy silane coupling agent	: 3 parts by weight
Triphenylphosphine	: 5 parts by weight
Carbon black coloring agent	: 1 part by weight

The above-mentioned compounds were sufficiently kneaded to obtain a thermosetting molding material. Meanwhile, as shown in Fig. 1(a), a creamy solder was applied at predetermined positions of a copper foil of 35 μm in thickness, and an IC encapsulated on a surface-mount type package of 1 mm in thickness (model name TSOP, JEDEC outline), a chip resistor of 0.6 mm in thickness (3216 size, JIS outline), a chip capacitor of 0.7 mm in thickness (3216 size, JIS outline) were mounted, followed by reflow

soldering so as to connect and fix the components. Two of such metal foils were prepared, and as shown in Fig. 1(b), they were disposed within a die having a cavity of 0.8 mm in depth on upper and lower sides so that their component mounting surfaces faced the inner side of the cavity. Then, the above-mentioned molding material was transferred and molded at 175°C for 90 seconds by means of transfer press, followed by curing at 175°C for 5 hours, whereby a double-sided copper coated board of 1.6 mm in thickness and of 100 mm per side was obtained as shown in Fig. 1(c).

Comparative Example 1

A glass cloth of 0.2 mm in thickness was impregnated with dicyandiamide curing system epoxy resin varnish, followed by drying so as to obtain a prepreg. Eight pieces of these were laminated and a copper foil that was used for Working Example 1 was disposed on each surface of the lamination. Then, heat and pressure were applied thereto for molding at 170°C for 90 minutes by means of press, whereby a copper coated laminated board of 1.67 mm in thickness was obtained.

A circuit pattern was formed on the thus obtained board as shown in Fig. 1(d), and surface-mount type components that were used for Working Example 1 were mounted on surface circuits on the surface and rear face thereof. Then, the number of mounted components in the direction of the thickness of the board was determined so as to evaluate the mounting density. Table 1 shows the results.

[Table 1]

Evaluation Results

Inserted components		The number of mounted components in thickness direction	
Components	Thickness (mm)	Working Ex. 1	Comparative Ex. 1
TSOP	1.0	3	2
Chip resistor	0.6	4	2
Chip capacitor	0.7	4	2

As is evident from Table 1, the mounting density of Working Example 1 was improved by 1.5 to 2 times, and therefore the higher density that was the objective of the present invention could be achieved.

(Effects of the Invention)

As is evident from the above description, the method of manufacturing a printed wiring board of the present invention allows electronic components to be embedded in an insulative layer of a board, thus enabling the miniaturization and high-density of electronic equipment, and therefore this method has great industrial significance.

4. Brief Description of Drawings

[Fig. 1] (a) to (c) are cross-sectional views showing the manufacturing process of a printed wiring board of the present invention, and (d) is a cross-sectional view showing the application example of the board that is obtained from the method of the present invention.

(Explanation of letters or numerals)

1 metal foil
2 electronic component
3 connecting material
4 upper die
5 lower die
6 cavity
7 insulative resin

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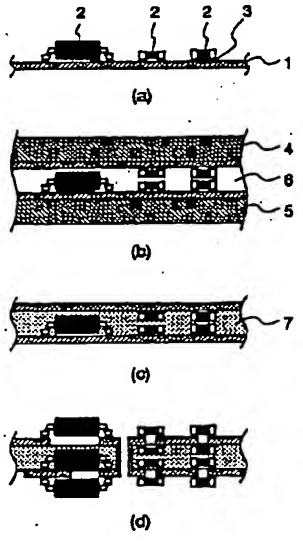
(54)【発明の名称】　印刷配線用基板の製造方法

(57)【要約】

【目的】　小型化、高密度化が可能な印刷配線用基板を提供すること。

【構成】　成形金型のキャビティ内に、片面に電子部品を電気的に接続した金属箔を電子部品搭載面がキャビティ内側に向くように配置し、次いで熱硬化性樹脂を用いた成形材料を注入、硬化する。



【特許請求の範囲】

【請求項1】　成形金型のキャビティ内に、片面に電子部品を電気的に接続した金属箔を電子部品搭載面がキャビティ内側に向くように配置し、次いで熱硬化性樹脂を用いた成形材料を注入、硬化してなることを特徴とする印刷配線用基板の製造方法。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、特に小型化、高密度化を必要とする機器に用いられる印刷配線用基板に関する。

【0002】

【従来の技術】電子機器を小型化、高密度化するためには、回路を構成する電子部品や基板等が占める空間をできるだけ小さくすることが重要である。電子部品については、表面実装型の電子部品にみられるように小型化、薄型化が進んでいる。また、部品を搭載する基板については、フレキシブル印刷配線板が従来より用いられている。フレキシブル印刷配線板は可撓性を持ったフィルムに導体パターンを形成したもので、基板自体が薄くかつ折り曲げることができるため狭い空間を有効に利用することができる。しかし、フレキシブル印刷配線板のベースフィルムは耐熱性が要求されるため、ポリイミド等の高価な樹脂が用いられている。また、可撓性を持っていることにより、部品の搭載作業時や機器への組み込み後の安定性という点で問題が残っている。一方、部品を搭載した基板を複数枚積層して部品を内蔵した多層板とすることにより小型化、高密度化を図る方法（例えば、特開平2—164096号公報、特開平4—44296号公報）や、電子機器の筐体に部品を内蔵する方法（例えば、特開昭57—50494号公報）がある。

【0003】

【発明が解決しようとする課題】前者の方法では、部品を内蔵する部分の基板に穴を設けなければならず、ザグリ等の加工が必要となり、複雑な穴明けはコスト的に不利である。また、内層回路に部品を接続するため、少なくとも1層以上の内層回路が必要となり、製造工程が複雑になる。後者の方法では、めっきにより形成した導体パターンを基板に転写するため、このめっき工程が必要となる。また、形成された導体層が片面のみであるため、回路の密度は片面印刷配線板と同等である。本発明はかかる状況に鑑みなされたもので、小型化、高密度化が可能な印刷配線用基板を提供するものである。

【0004】

【課題を解決するための手段】すなわち本発明は、成形金型のキャビティ内に、片面に電子部品を電気的に接続した金属箔を電子部品搭載面がキャビティ内側に向くように配置し、次いで熱硬化性樹脂を用いた成形材料を注入、硬化してなることを特徴とする印刷配線用基板の製造方法に関する。以下、図1を用いて本発明を詳細に説明する。

【0005】図1（a）～（c）に本発明の印刷配線用基板の製造方法の例を示す。まず、図1（a）に示すように、金属箔1上に電子部品2を接続材料3を用いて接続し固定する。次に、図1（b）に示すように、上型4及び下型5から構成されるキャビティ6内に、上記金属箔を部品搭載面がキャビティ内側に向くように配置し、これに熱硬化性樹脂を用いた成形材料を注入硬化させる。このようにして、図1（c）に示すような絶縁樹脂7に部品を内挿した印刷配線用基板が得られる。金属箔は表層回路となる導体で特に限定するものではなく、用途に応じてどのようなものでもよいが、電気接続性や回路形成性、価格等から考えて一般の印刷配線用基板に使用されている銅箔が好ましい。また、その厚さは必要に応じて適宜選択できる。金属箔の形状は特に制限はなく、基板全体と同じ大きさでもよいし、部分的に複数箇所配置するようなものでもよい。このような金属箔の電子部品を搭載する面には、電子部品のリード等を接続する部分以外にソルダレジスト等の保護被膜を形成してもよい。また、金属箔の絶縁樹脂と接する部分は、粗化したりカップリング剤や接着剤等の処理を施すことにより、絶縁樹脂との接着性を向上することができる。

【0006】金属箔に搭載する電子部品は特に限定するものではないが、表面実装型の部品、例えば表面実装型パッケージに封止されたIC、トランジスタ、ダイオード等の能動素子や、チップ抵抗、チップコンデンサ、チップコイル等の受動素子等が好適である。また、配線の一部となる金属線や金属板、封止されていないICやトランジスタ等のベアチップ等を搭載してもよい。これらの電子部品の大きさは特に制限はないが、基板の厚さより薄いものを用いた場合には凹凸の無い基板を得ることができる。更に、基板の半分以下の厚さの部品を用いた場合には基板の厚さ方向で重ねることができ、実装密度を向上することができる。

【0007】金属箔に電子部品を接続する接続材料としては、一般的なはんだ、導電性ペースト等を用いることができる。また、半導体素子をベアチップの状態で搭載する場合には、金やアルミの接続線（ボンディングワイア）を用いたり、金やパラジウム、はんだ等のバンプを用いて接続することもできる。基板を成形する成形金型のキャビティ形状は特に限定するものではなく、成形できるものであればどのようなものでもよい。本発明方法で得られた基板を従来の基板と同等の工程で回路形成や組立を行なう場合には、平板状のキャビティが好ましい。

【0008】絶縁樹脂は熱硬化性樹脂を用いた成形材料の硬化物である。熱硬化性樹脂としては、フェノール樹脂、エポキシ樹脂、ポリイミド樹脂、不飽和ポリエステル樹脂、トリアジン樹脂等どのようなものでもよく、何種類か併用してもよい。特に、エポキシ樹脂に硬化剤と

してフェノール樹脂を配合した系では耐熱性、電気特性等に優れている。また、これらの樹脂には硬化反応を促進する硬化促進剤や難燃性を付与する難燃助剤、着色剤、離型剤などの添加剤を適宜適量配合することができる。

【０００９】このような樹脂系には種々の充填剤を配合することにより、熱伝導率を向上したり熱膨張係数を内挿部品に整合することができる。例えば溶融シリカ、結晶シリカ、アルミナ、窒化珪素等の無機物や、シリコーン、テフロン等の有機物の粉末等が使用でき、単独または何種か併用してもよい。充填剤の粒径は成形金型のゲートに詰まらない程度の大きさ以下であればよく、またその形状はどのようなものでもよい。充填剤の配合量は特に限定するものではないが、樹脂組成物の溶融粘度や硬化物の熱膨張係数等から２０～８０体積%の範囲が好ましい。充填剤を配合する場合、樹脂との接着性を高めるためシラン系カップリング剤に代表されるような表面処理剤を添加してもよい。成形方法については注型、移送成形、射出成形、圧縮成形等一般の成形材料の成形方法を用いることができ、必要に応じて加熱、加圧してもよい。図１（ｄ）に、本発明方法により得られた印刷配線用基板に、めっきスルーホールと回路パターンを形成し、部品を搭載したものの例を示す。

【００１０】

【作用】本発明方法で得られた印刷配線用基板は、絶縁樹脂層に電子部品を内挿しているため、従来の基板と比較し、最高で２倍の高い実装密度が得られる。また、絶縁樹脂が熱硬化性樹脂を用いた成形材料の硬化物であるため、優れた耐熱性が得られる。更に、成形材料を用いることで、部品を内挿するためのザグリ等の穴明けは一切不要である。

【００１１】

【実施例】以下、実施例に基づき本発明を説明するが、本発明はこの実施例に限定されるものではない。

【００１２】実施例１

ＥＳＣＮ―１９５（住友化学(株)製オルソクレゾールノボラック型エポキシ樹脂、商品名）	：１００重量部
ＨＰ―８００Ｎ（日立化成工業(株)製フェノールノボラック樹脂、商品名）	：　５０重量部
アルミナ粉	：９５０重量部
エポキシシランカップリング剤	：　　３重量部
トリフェニルホスフィン	：　　５重量部
カーボンブラック着色剤	：　　１重量部

上記化合物を充分混練して熱硬化性の成形材料を得た。一方、図１（ａ）に示すように、厚さ３５μｍの銅箔の所定の位置にクリームはんだを塗布し、厚さ１㎜の表面実装型パッケージ（型名ＴＳＯＰ、ＪＥＤＥＣ外形）に封止されたＩＣと、厚さ０．６㎜のチップ抵抗（３２１６サイズ、ＪＩＳ外形）、厚さ０．７㎜のチップコンデンサ（３２１６サイズ、ＪＩＳ外形）を搭載してリフローはんだ付けを行ない、接続、固定した。このような金属箔を２枚用意し、図１（ｂ）に示すように、上下とも深さ０．８㎜のキャビティを有する金型に部品搭載面がキャビティ内部に向くように配置し、これに上記成形材料を移送プレスで１７５℃、９０秒で移送、成形したものを１７５℃、５時間後硬化して、図１（ｃ）に示すような厚さ１．６㎜、１００㎜角の両面銅張基板を得た。

【００１３】比較例１

ジシアンジアミド硬化系エポキシ樹脂ワニスを厚さ０．２㎜のガラス布に含浸させた後、乾燥させプリプレグを得た。これを８枚積層し両面に実施例１で用いた銅箔各１枚を配置し、プレスにより１７０℃、９０分加熱、加圧成形して厚さ１．６７㎜の銅張積層板を得た。

【００１４】以上のようにして得られた基板に、図１（ｄ）に示すように回路パターンを形成し、表裏面の表層回路上に実施例１で用いた表面実装部品を搭載して、基板の厚さ方向での実装部品数を求めて実装密度を評価した。結果を表１に示す。

【００１５】

【表１】

評価結果

内挿部品		厚さ方向の実装数（個）	
部品名	厚さ(mm)	実施例1	比較例1
TSOP	1．0	3	2
チップ抵抗	0．6	4	2
チップコンデンサ	0．7	4	2

【００１６】表１から明らかなように、実施例１の部品実装密度は１．５～２倍と向上し、本発明の目的である高密度化を達成することができた。

【００１７】

【発明の効果】以上の説明から明らかなように、本発明の印刷配線用基板の製造方法は、基板の絶縁層内に電子部品を内蔵することができ、電子機器の小型化、高密度化が図れるため、その産業的価値は高い。

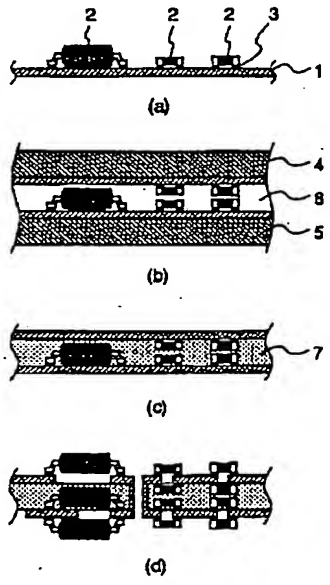
【図面の簡単な説明】

【図１】（ａ）～（ｃ）は本発明の印刷配線用基板の製造工程を示す断面図、（ｄ）は本発明方法により得られた基板の応用例を示す断面図である。

【符号の説明】

１…金属箔、２…電子部品、３…接続材料、４…上型、５…下型、６…キャビティ、７…絶縁樹脂

【図１】



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